National Aeronautics and Space Administration
Ames Research Center
Statement of Work
Revised August 27, 2002

Information Technology Survey and Gap Assessment

I. Background

While NASA must undertake risks to expand the understanding of space, NASA's primary objective is to do so in as safe a manner as possible. Current budgetary and operational constraints, and recent NASA mishaps, require NASA to redouble its efforts to successfully infuse and guide design and operations decisions from a risk-based perspective. Moreover, while NASA has traditionally mitigated many risks through mechanical design redundancy and fault tolerance, to achieve future mission success, methods must now be developed to assess and mitigate risk in the software or human/organization elements of the system throughout its lifecycle.

NASA has two major information technology-based programs which are designed to improve the capability and success of future NASA missions. The first is the Computing, Information, and Communications Technology (CICT) program. The objectives of this program are to: (1) enable new classes of missions and resilient systems through development of autonomy, intelligent control and health management technologies, and (2) increase mission assurance through the development of high-dependability software technologies. This program is focussed on research and feasibility demonstrations of relevant technologies.

The second program is the Engineering for Complex Systems (ECS) program. A central thrust of ECS is to explore how advanced information technologies can make system safety and risk assessment a basic system property throughout the life cycle of all NASA systems. It will also explore how advanced concepts and technologies, especially those for intelligent systems and autonomous model-based information technologies, can be utilized to ensure our extremely complex systems are designed and operated safely. This program is focussed on technology maturation and applied demonstrations of its relevant technologies.

Both of these programs have a common need in the matching and contrasting of their respective technology development portfolios with the state of the art, and emerging direction, of information technologies. To develop the appropriate portfolios of required technology development activities, CICT and ECS plan to jointly assess the current state of information technologies in academia, industry, and government, and to develop a gap analysis capability as a part of their overall technology portfolio management strategy.

II. Task Objective

The objective of this statement of work is to assess the current state of technology development within academia, other government agencies, and industry, as it relates to the CICT/ECS program and project elements. This activity is in support of defining the technology development requirements for the CICT/ECS programs. The contractor shall have access to Program personnel and key researcher and principal investigators within CICT and ECS as appropriate.

Contractor needs to be able to handle company proprietary/sensitive information and provide non-disclosures agreements as required.

Task 1 – Information Technology Survey.

Subtask 1.1 Conduct a structured survey of information technologies within academia, other government agencies, and industry, respectively. Focus should be on technologies which are at Technology Readiness Level 6 (see Appendix 1) or lower (i.e., integrated prototype demonstration in relevant environment). Minimum number of technologies to be surveyed: 250. Identified technologies should augment (i.e., in general, no duplication) existing ECS technology database. This database will be provided by NASA (see Item 1 under Section III, *Government Furnished Information*).

Survey should include:

- Name of technology (or tool, methodology, product)
- Description
- Organization (Academia, U.S. Government, Commercial)
- Contact Information (name, phone, e-mail, website)
- Assessment of technology
  - Current readiness level (see Appendix 1)
  - Technology rate of change
  - Approximate investment (over specified time frame)
  - Technology domain categorization (see Appendix 2)
  - Overall priority/ranking

Subtask 1.2 Review, vet, and assess identified technologies for technical accuracy and relevance to NASA objectives. Revise above technology assessment as required.

Subtask 1.3 Technology Database. Build an electronic database using technologies identified and information captured under Subtasks 1.1 and 1.2, augmented by the existing ECS Technology Database. Database should be searchable, should be easy to use with minimal or no training, and should allow some analytical capability to assess numbers of technologies by domain, overall investment levels, etc. See Section IV, *Deliverable*s for additional database requirements, and Appendix 3 for example technology output. The functionality of the database will be reviewed and approved by NASA.

Task 2 – Technology Assessment. Conduct an assessment of technology gaps between surveyed technologies versus NASA future mission requirements (see Item 3 under Section III, *Government Furnished Information*). To what extent or degree does the current state of these technologies meet these requirements? Identify capabilities and limitations in the domain of identified technologies (see Appendix 2), and assess future technology maturation rates and trends toward meeting requirements. Provide a detailed examination of at least one technology in each of the domain areas in Appendix 2. Recommend specific technologies or technology domains for increased government investment. Also, provide recommendations for revisions and maintenance of the technology survey and gap analyses processes beyond Fiscal Year (FY) 02.

III. Government Furnished Information

1. DFS Technology Assessment & Analysis final report of **8-31-01**, final report summary, and technology data sheets performed by Arthur Andersen LLP under contract number A61895D(GVW) dated **March 30, 2001**, and A64739D (GVW) dated
2. CICT and ECS Program Documentation (e.g., program plan) as appropriate.
3. List of targeted NASA missions.

IV. Deliverables

1. Final Report. A written report detailing the approach, assumptions, research bibliography, detailed findings, and recommendations shall be provided. The report should be provided in electronic and hard copy versions (15 copies required). The contractor will provide a draft copy for review by NASA.
2. Electronic Database. An electronic database (in Microsoft ACCESS or Filemaker Pro format) shall be provided. The database should be configuration controllable and allow for periodic updating. The database should be searchable and allow creation of reports. Database format and required data fields are provided by NASA.
3. Reviews. The following reviews shall be conducted by the Ames Research Center and the contractor. All reviews will be held at ARC.`
4. Study Approach Review. ARC will review and concur with the proposed scope and approach of the contractor to complete the SOW tasks.
5. Interim Status Review. ARC will conduct review to assess contractor progress.
6. Study Results Review. Contractor will present results of study activities. ARC will provide comments on draft final report.

All electronic deliverables shall be in source format, i.e., MS Word, MS Excel, MS Powerpoint, Adobe Framemaker, Adobe Illustrator, etc., as applicable. Technology data sheets will be provided in the similar electronic form and format as the previous contract conducted by Arthur Andersen LLP (See Paragraph III.1, Government Furnished

Information above). Portable Document Format (PDF) files shall not be acceptable alone.

V. Schedule

Milestone	Due Date
Study start date	08/29/02
Review study approach	09/10/02
Interim Status/Database Functionality Review	10/17/02
Draft Final Report	12/10/02
Review Study Results	12/20/02
Final Report	01/14/03

Appendix 1: Technology Readiness Levels

The following figure represents the technology readiness level (TRL) thresholds commonly utilized by NASA.

NASA Technology Readiness Levels

Appendix 2: Relevant Technology Domains

High Confidence Software
- High Dependability Software
- Software V&V

Advanced Computing and Communications
- High-Performance Computing Systems
- Distributed Computing Architectures
- Advanced Networking and Space Communications
- Quantum Computing Algorithms
- Evolvable Systems

Intelligent Systems
- Automated Reasoning
- Expert Systems

Information & Knowledge Management
- Intelligent Data Understanding
- Unobtrusive Intelligent Search Agents
- Data Fusion, Mining, Feature Extraction, Classification

Information Systems
- Networks & Distributed Info Systems
- Information and Collaboration Environments

Autonomous Systems & Operations
- Autonomous Robotics
- Intelligent Flight Controls
- Mission Data Systems
- Autonomous Systems for Spacecraft

Integrated Vehicle Health Management
- System Level Diagnostics & Prognostics
- Data/Sensor Fusion and System Health Assessment
- Integrated System Test & Validation

Design
- Integrated Design Environments
- Risk-Based Design
- Modeling & Simulation
- Probabilistic System Modeling

Risk Assessment & Management
- Human & Organization Risk Management
- Probabilistic Risk Assessment
- Risk Profiles/Distributions
- Interaction/Hazard Analysis

Human-Machine Interaction
- Human Centered Computing
- Human/Automation Integration Research
- Human Error and Countermeasures
- Psychological/Physiological Stressors and Factors

Multi-sensory/multi-media interfaces

Bio/Nanotechnology

Nanoscale Assembly

Nanoelectronics and Computing

Bio Molecular Nanotechnologies

Bio-inspired Systems

Appendix 3: Example Technology Data Sheet

ID# 243

SRRM 1.2 Human & Organizational Risk Management

Organization/Company: INEEL (Idaho National Engineering and Environmental Laboratory) ***Organization type:*** Government

Address: Boise Regional Office 800 Park Blvd., Suite 790, Boise, ID 83713 United States

URL: www.inel.gov/capabilities/human-systems/simulations.asp ***Telephone Number:*** (208) 526-1756 ***Fax Number:***

Contact Person: Mr. David Gertman ***E-mail:*** gertdi@inel.gov

Product Name Human Error Contribution to Risk in Operating Events

TechnologyDescription:

DESCRIPTION: This research product is aimed directly at Human Reliability and Risk Assessment. It provides a framework and methodology that effectively combines Human Reliability Analysis (HRA) and Probabilistic Risk Assessment (PRA). The result is a means for ascertaining the degree of incremental risks associated with operations under varying conditions in such a way that human performance can be assessed and past trends for system safety can be identified and used for analysis.

TECH FIT: This research initiative represents a category 1.2 technology based upon the attributes of Decision Analysis and Modeling and Dynamic Risk Assessment Tools.

ORGANIZATION: INEEL has been in operation since 1949 as a U.S. multiprogram laboratory that supports the Department of Energy's missions of environmental quality, energy resources, science, and national security. Bechtel Idaho, LLC is the prime contractor responsible for the

Assessment Results

1) 5 years ago, TML was : 4

2) TML level today: 9

3) It will take 0 years to achieve TML 7.

4) Less than XXX million dollars was allocated to develop this technology in the past year.